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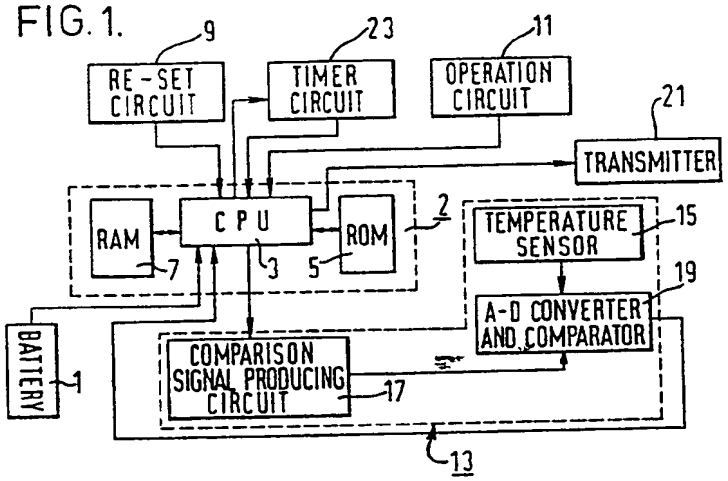
(54) Wireless control of temperature

(57) A temperature control apparatus for a heating or cooling apparatus with a temperature sensor 15, a computer 2 producing a control signal in response to temperature during an operation period and thereafter entering a halt period, a transmitter 21 for sending the control signal to the heating or cooling apparatus and a timer 23 for controlling the computer. The timer 23 is activated by commencement of the operation period to reactivate the computer after a predetermined time. A desired temperature is set at 11. The CPU 3 produces a ramp voltage by circuit 17 for comparison with the measured temperature; a high or low signal is sent from 19 to CPU 3 according to whether the instant temperature is above or below the ramp level.

FIG. 1.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

FIG. 1.

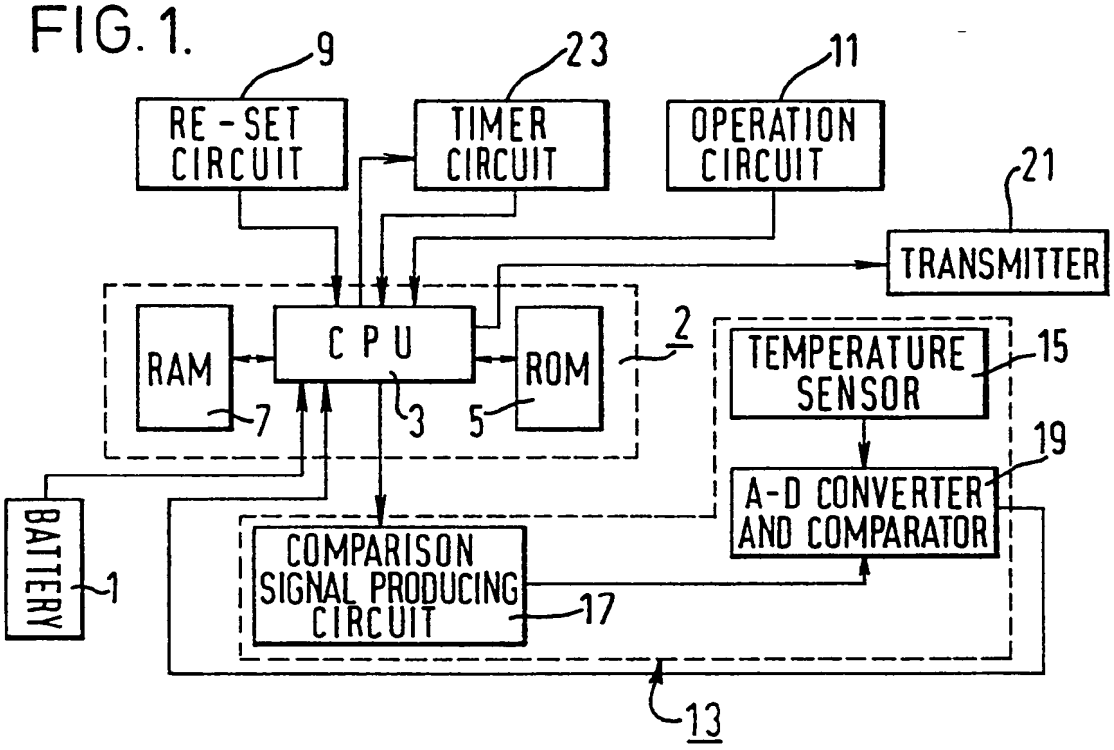

FIG. 2.

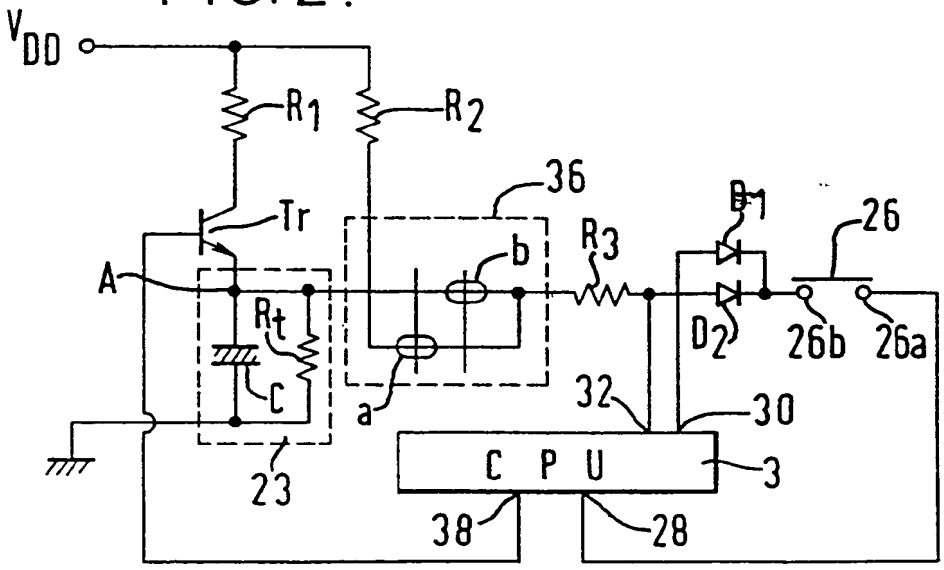

FIG.3A

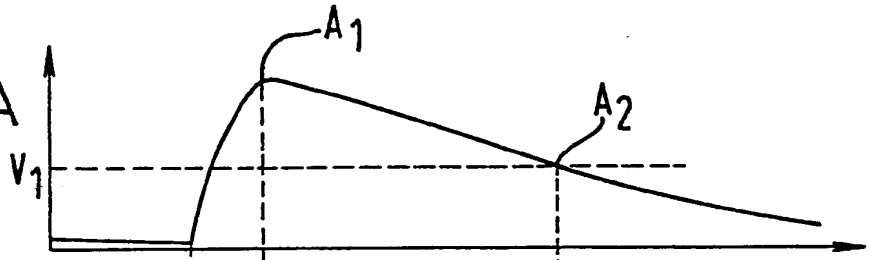

FIG.3B.

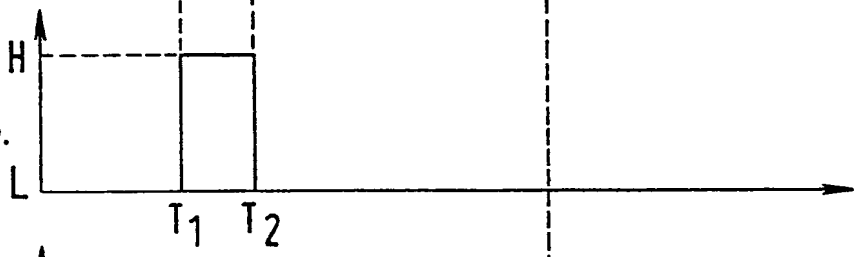

FIG.3C.

SPECIFICATION

Wireless remote control apparatus and method of operating

The present invention relates to a temperature control apparatus for a heating and/or cooling apparatus, in particular, to a wireless remote control apparatus using a battery as a power supply, and its operating method.

Wireless type remote control apparatus are now used for controlling apparatus such as air conditioners. Conventionally this control apparatus uses a battery as a power source. Since it is troublesome to frequently change batteries, small power consumption is required of this type of control apparatus.

One known apparatus of this type includes a temperature sensing circuit for detecting the temperature in a room, a comparing circuit comparing the detected temperature with a desired temperature and producing a signal, a transmitting circuit sending the signal to the apparatus to be controlled, such as an air conditioner, and a timer. the timer enables the remote control apparatus to detect the temperature and to send a regular signal intermittently. This apparatus has relatively low power consumption, but further reduction in consumption is desirable. Because the timer is operated irrespective of operation of the circuits described above, it takes longer than necessary to completely carry out the circuit operations. In other words, in spite of completion of the 30 operations, the circuits are still supplied with useless power by the timer.

It is an object of the present invention to provide an improved wireless type remote control apparatus achieving small power consumption.

It is another object of the invention to provide a unique operating method of a wireless type remote control apparatus.

According to one aspect of the present invention there is provided a wireless type control apparatus for controlling a heating or cooling apparatus comprising:

temperature sensing means for producing a signal indicating the temperature;

computer means having a CPU, for receiving said temperature signal and producing a control signal in response thereto during an operation period and thereafter entering a halt period;

transmitting means for transmitting said control signal to said heating or cooling apparatus; and

timer means for controlling the operation and halt state of the CPU, said timer being activated by the commencement of said operation period and reactivating said computer means after passage of a predetermined time.

According to a second aspect of the present invention there is provided a method of operation of a wireless type control apparatus including a temperature sensing means, a microcomputer having a CPU, a transmitting means, and timer means, having a C-R timer comprising the steps of:

sensing a temperature and producing from the temperature sensing means a temperature signal corresponding to the sensed temperature;

producing a control signal from the CPU in response to said temperature signal;

transmitting the control signal from the transmitting means to an apparatus to be controlled in response to a transmit command from said CPU;

producing a given signal from the CPU when the second or the third step is completed;

charging the C-R timer in response to the given signal;

producing a signal from the CPU and causing the CPU to enter the halt state when a voltage of the C-R timer has reached a prescribed potential;

discharging the voltage of the C-R timer; and

shifting from the halt state of the CPU to the operation state when the discharged voltage of the C-R timer has fallen to a predetermined potential.

For a better understanding of the present invention reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows a block diagram of an embodiment of a wireless remote control apparatus according to the present invention used for an air conditioner;

Figure 2 shows a circuit diagram of a timer circuit of Figure 1; and

Figure 3A, 3B and *3C* show time charts showing respectively the voltage at point A in the circuit diagram of Figure 2, the output of the CPU output port 38 and the operation and halt period of the CPU.

An embodiment of the present invention will now be described in more detail with reference to the accompanying drawings.

Referring to Figure 1, the wireless remote control apparatus includes a battery 1 as a power source, a microcomputer 2 composed of CPU 3, ROM 5 and RAM 7, a re-set circuit 9 for providing a re-set signal to a re-set terminal of the CPU prior to the commencement of operation of the microcomputer 2, and an operation circuit 11 for presetting a desired temperature in a room. The operation circuit 11 is provided with an on and off switch for controlling the conditioner. A temperature sensing circuit 13 includes a temperature sensor 15 for sensing the temperature in the room and producing a first temperature signal (an analog value corresponding to the sensed temperature), a comparison signal producing circuit 17 for producing a second signal in response to an output of the CPU, and an A-D converter circuit 19 which also compares the first signal with the second signal to produce a third signal (a digital signal). A transmitter 21 sends from the CPU to the apparatus to be controlled a control signal, modulated with light or sound waves, in accordance with the third signal.

Operation of the above-described circuits will be described hereinafter. The CPU sends its output sequentially to the comparison signal producing circuit 17, and causes it to produce the second signal (a progressive step function voltage). The second signal and the first signal, corresponding to the detected temperature fed from the temperature sensor 15, are compared in the A-D converter and comparator circuit 19. As a result, circuit 19 produces the third signal. When the output (the third signal) of the A-D converter 19 changes from L (a low level potential) to

H (a high level potential) or from H to L, the CPU detects the temperature at that time on the basis of the output from the CPU to the comparison signal producing circuit 17. then, the CPU converts to the control signal either the detected temperature itself or, for example the difference between the detected temperature and a desired temperature, and sends the control signal to the transmitter 21. The transmitter 21 received the control signal from the CPU, and sends it modulated with either light or sound waves to a receiver in the air conditioner (not shown). Operations of the air conditioner are then carried out according to the control signal. A construction of a timer circuit 23 and the CPU which are usable in the embodiment of the present invention will now be described.

The wireless type remote control apparatus further includes timer circuit 23, such as e.g., a C-R timer, for determining the halt period of time of the CPU, which is controlled by a fourth signal (a high level potential) fed from the CPU. The CPU produces a fifth signal (a low level potential) and enters the halt state by itself when the timer circuit 23 is charged up.

Figure 2 shows a circuit diagram of a C-R timer as an example of a suitable timer circuit and CPU. A switch 26 in the operation circuit 11 is the on and off switch. One end 26a of the switch 26 is connected to an output port 28 of the CPU, while the other end 26b is connected to an output port 30 of the CPU through a backward connected diode D1, and is connected to an operation - halt port 32 through a backward connected diode D_2. A power supply voltage V_{DD} is connected to the emitter of a NPN transistor Tr through a resistor R_2 to a contact a of a switch 36 for selecting a temperature sensing mode.

The base of transistor Tr is connected to an output port 38 of the CPU, and the emitter is grounded through the C-R timer 23. The C-R timer 23 is formed with a parallel connected circuit of a resistor Rt and a capacitor C. A connecting point A between the emitter of the transistor Tr and the C-R timer 23 is connected to the operation-halt port 32 through a contact b of switch 36 and a resistor R_3. The switch 36 enables the user to select the temperature sensing position (the remote control apparatus side or the apparatus side to be controlled).

When switch 36 is at the contact a, temperature sensing is carried out at the apparatus side to be controlled. The CPU operates only when the on and off switch 26 is operated and then shifts to the halt state after sending a signal (on or off signal) once.

When the switch 36 is at the contact b, temperature sensing is executed at the remote control 35 apparatus side. A detailed operation will be described as follows.

When on and off switch 26 is closed, an L output (a low level potential) of the output port 28 is applied to the operation-halt port 32 through the diode D_2. The CPU 3 responds to the change from H (a high level potential) to L of the operation halt port 32 and begins operation. When the CPU starts operation, the comparison signal producing circuit 17 and the A-D converter 19 operate and the first signal (the sensed temperature) produced by the sensor 15 is converted to the third signal (a digital signal) and applied to CPU 3. At this time, if a transmit command is in the CPU, this command is carried out by the transmitter 21. The conditions producing the transmit command are as follows:

1) When the difference between the latest temperature and the prior temperature is greater than a prescribed constant value;

2) When a predetermined period of time passes after the prior temperature data has been transmitted; or

3) When the on and off switch is operated.

Then, once one temperature detecting cycle is completed, the CPU outputs the fourth signal (a high level potential) from the output port 38 (time T_1 as shown in Figure 3B). The fourth signal is sent to the base of transistor Tr, transistor Tr is turned on, and power is supplied to C-R timer 23. A charge therefore builds up on the capacitor C of the C-R timer 23, and the voltage at the emitter of transistor tr (point A in Figure 2) gradually rises. After the voltage of the capacitor C has reached a sufficient charged level, (point A_1, in Figure 3A), CPU 3 produces the fifth signal (a low level potential at time T_2 in Figure 3B) and enters the halt state at time R_3 in Figure 3C. At the same time, since the fifth signal is sent to the base of transistor Tr, transistor Tr is turned off, and the C-R timer 23 discharges. In other words, the accumulated charge in the capacitor C flows to earth through the resistance Rt, and the voltage potential of the point A shown in Figure 2 gradually falls (from point A_1 in Figure 3A). At this time, the CPU stays in the halt state. then, when the voltage potential of point A falls from point A_1 to point A_2 (as shown in Figure 3A), at which the voltage potential has fallen to a standard voltage V_1 used by the CPU to distinguish H (high level potential) and L (a low level potential), the CPU again begins operation at time T_4 in Figure 3C. Therefore, the CPU goes through repeated above-described duty cycles.

As described above, according to the embodiment of the present invention, the CPU is operated only for the period of time of approximately 500 microseconds necessary for detecting the temperature, and after that the CPU stays in its halt state for a predetermined period of time such as e.g. 3 minutes by means of the C-R timer. As a result, the power consumption of the control apparatus including the CPU by the above-described construction and its operating method is low, so that battery life which was formerly only some tens of days is extended to some months or a year or longer. Thus, excellent energy saving is obtained. The extended battery life avoids troublesome battery replacements, providing convenience in use. Additionally, it is possible to reduce the battery size and numbers in the wireless type remote control apparatus, and to make the apparatus more compact.

Various modifications will become apparent for those skilled in the art having the benefit of the teachings of the present disclosure without departing from the scope thereof. Thereafter, the claims should be constructed to include such modification.

CLAIMS

1. A wireless type control apparatus for controlling a heating or cooling apparatus comprising:

temperature sensing means for producing a signal indicating the temperature;

computer means having a CPU, for receiving said temperature signal and producing a control signal in response thereto during an operation period and thereafter entering a halt period;

transmitting means for transmitting said control signal to said heating or cooling apparatus; and

timer means for controlling the operation and halt state of the CPU, said timer being activated by the commencement of said operation period and reactivating said computer means after passage of a predetermined time.

2. A wireless type control apparatus according to claim 1, wherein said temperature sensing means includes a comparison signal producing circuit which produces a comparison signal in response to an output of the CPU and means for comparing said comparison signal with said temperature signal.

3. A wireless type control apparatus according to claim 2 in which said comparing means include an A-D converter.

4. A wireless type control apparatus according to claim 1, wherein said timer means includes a C-R timer, which begins to charge when said timer means receives a signal from the CPU, and said CPU produces a signal and enters said halt state itself when the C-R timer has reached a prescribed charged level, and which beging to discharge when said timer means receives a signal from the CPU, and said CPU again begins operation when the voltage potential of the C-R timer has fallen to a prescribed level.

5. A method of operation of a wireless type control apparatus including a temperature sensing means, a microcomputer having a CPU, a transmitting means, and a timer means, having a C-R timer comprising the steps of:

sensing a temperature and producing from the temperature sensing means a temperature signal corresponding to the sensed temperature;

producing a control signal from the CPU in response to said temperature signal;

transmitting the control signal from the transmitting means to an apparatus to be controlled in response to a transmit command from said CPU;

producing a given signal from the CPU when the second or the third step is completed;

charging the C-R timer in response to the given signal;

producing a signal from the CPU and causing the CPU to enter the halt state when a voltage of the C-R timer has reached a prescribed potential;

discharging the voltage of the C-R timer; and

shifting from the halt state of the CPU to the operation state when the discharged voltage of the C-R timer has fallen to a predetermined potential.

6. A method as in claim 5, further including the step of producing a comparison signal when the temperature sensing means receives an output from the CPU.

7. A method as in claim 6, further including the step of comparing the temperature signal with the comparison signal.

8. A wireless type control apparatus substantially as hereinbefore described with reference to the accompanying drawings.

9. A method of operation of a wireless type control apparatus substantially as hereinbefore described with reference to the accompanying drawings.

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FIG. 1.

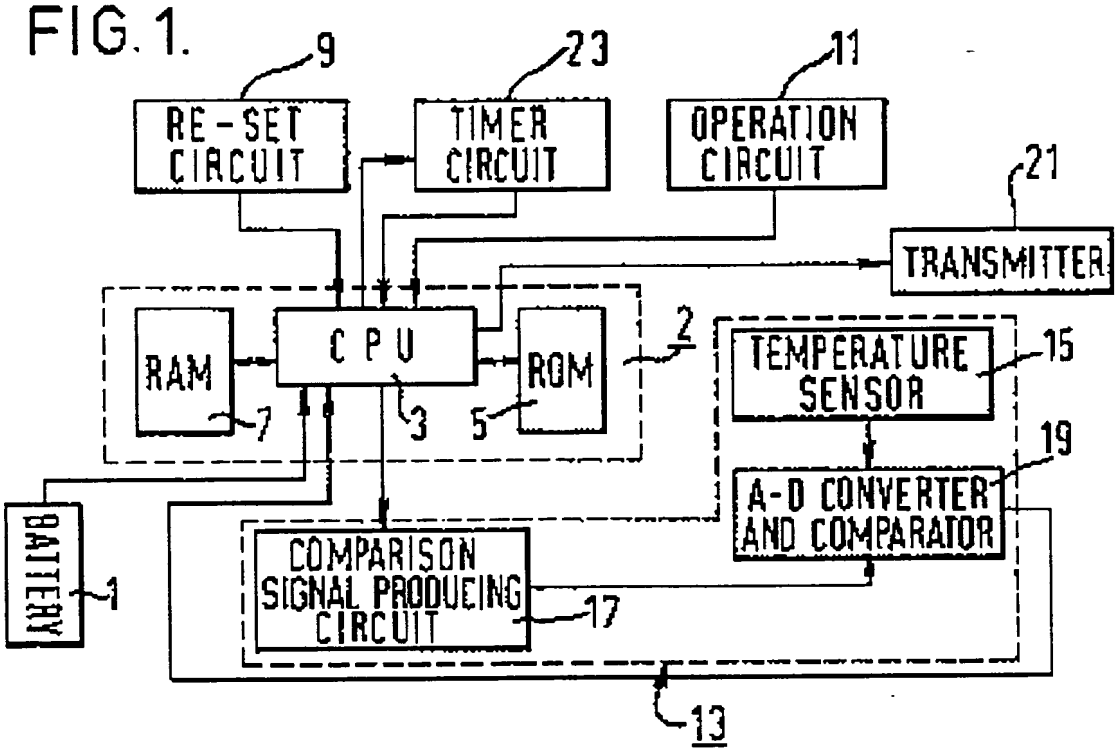

FIG. 2.

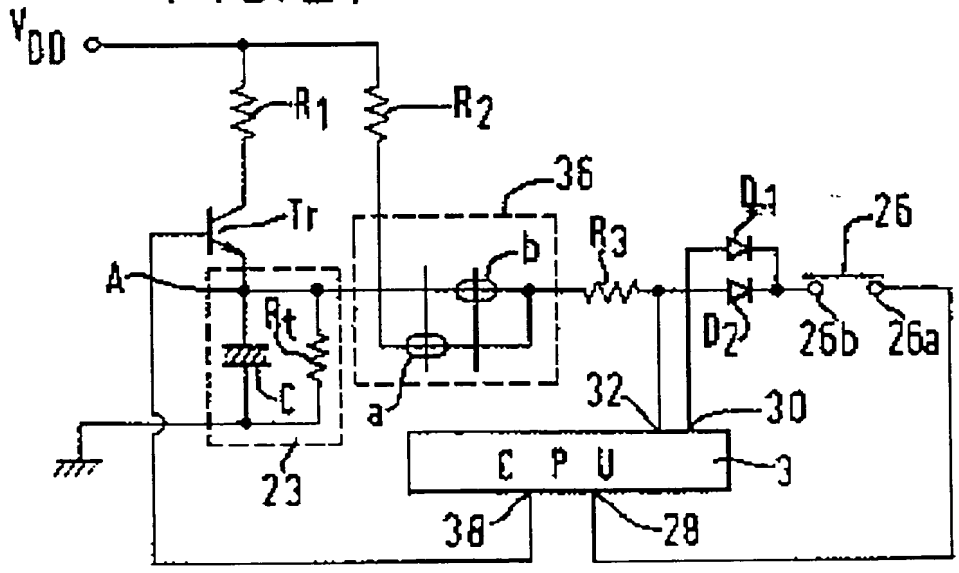

FIG.3A

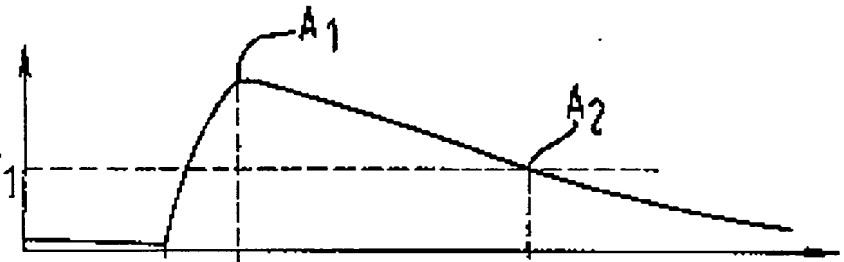

FIG.3B.

FIG.3C.